MINITAB HEADQUARTERS

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Senior Thesis Report
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Special Thanks to…

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Building Construction

Mr. Rick Seitz - Vice President
Mr. Steve Wilt - Project Manager
Mr. Jamie Horner - Project Engineer
Ms. Jeanette Mahoney - Administrative Assistant

Thank you so much for all your help !

Minitab, Inc.
Quality Plaza
1829 Pine Hall Road
State College, PA 16801

Thank you for allowing me to use your beautiful facility for my thesis !

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EXECUTIVE SUMMARY

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Minitab Headquarters is an 88,000 SF, four-story office building with a total cost of $14M. The building will house Minitab, Inc. general offices and executive offices. There are two-hundred nine offices, eighteen conference rooms, a media room, exercise area, and game room. The exterior alternates a panelized exterior insulation finish system and glass ribbon windows. While the heart of the building is typical of an office building, these special features serve to set the building apart and make working in or visiting a truly unique experience.

An analysis was conducted to compare the current EIFS exterior cladding system to the use of a precast concrete panel system. The purpose of this analysis is to investigate the life cycle costs, determine the maintenance schedule and associated costs, and provide a best value analysis. Initial installation cost for the EIFS is $344,761, precast concrete curtainwall panels is $275,377; a $69,384 initial cost savings to EIFS. Calculated thirty-year life cycle costs lead to a total precast concrete savings of $59,559 to the EIFS.

The original mechanical system designed by the MEP engineer was a Dedicated Outdoor Air System (DOAS) with a parallel radiant panel system. A problem arose with the original design; the engineer did not consider the structural loads imposed by the boiler and chiller located on the roof. The Owner chose to investigate other possibilities for the mechanical system. An alternate design-build mechanical contractor concluded that a geothermal system could be installed for the same cost as the original design and would not require building layout or structural redesign, therefore making it less expensive by comparison. Based on this review, the contractor was retained as the mechanical design-builder to implement a ground-source geothermal system. The new system, that meets the load requirements set by the prior system, results in a cost savings of $200,000.

A study was conducted to determine the possibilities of Minitab pursuing credits to achieve a LEED™ rated building. Minitab prides itself on being a satisfying and enjoyable place to work. Green building possibilities echo the environmental and human health consciousness of the company. The focus of their effort is to provide an atmosphere conducive to employee health, quality of life, and productivity. LEED™ rating system points categories are investigated to offer areas and processes where Minitab may able to accumulate points toward certification.

SECTION 1
PROJECT DESCRIPTION

Project Background
Exterior Cladding System
Client Information
Contractor Selection
Project Team
Project Information
Project Delivery System
Project Schedule Summary
Site Plan

SECTION 1: PROJECT DESCRIPTION

Project Background

Minitab Headquarters is an 88,000 SF, four-story office building with a total cost of $14M. The building will house Minitab, Inc. general offices and executive offices. Preconstruction services began in January 2001 with construction commencing the end of June 2001. The project was completed in November 2002.

This impressive facility boasts an exposed basement (referred to as the Garden Level) with a large atrium, pond and waterfall. Glass elevators in the lobby service all floors. There are two-hundred nine offices, eighteen conference rooms, a media room, exercise area, and game room. The exterior alternates a panelized exterior insulation finish system and glass ribbon windows. While the heart of the building is typical of an office building, these special features serve to set the building apart and make working in or visiting a truly unique experience.

Exterior System (Façade)

The exterior skin of the building is comprised of prefabricated EIFS panel assemblies and 4 foot seamless mullion ribbon windows (Figure 1.1). Below the bottom run of windows, the building is glass-fiber-reinforced panels (GFRC). This system resulted in many joints in the EIFS panels, which characteristically lead to moisture problems. Centre Region Code Administration issued a new regulation regarding the use of EIFS just prior to the start of construction. The new regulation required the use of a water managed system to control penetrant water behind the EIFS panels, a moisture barrier with a series of weep holes is installed behind the panelized system. The cost of the original system was $266,515. The new regulation requirements increased that amount by $68,000 for a total adjusted cost of $334,515.

Figure 1.1 The building façade alternates EIFS panels with 4 ft. seamless mullion ribbon windows.

PROJECT DESCRIPTION

Client Information

Minitab, Inc. is a developer of data analysis software in State College, Pennsylvania. Previously they occupied two buildings in the CATO Industrial Park, just down the street from their new home. Being split into two buildings caused difficulty in communication within the company. They wished to house all services under one roof to alleviate this problem. Minitab, Inc. announced the desire to build a new facility in 2000 and, based on an existing relationship, began working with architect Michael C. Haluga of State College. A decision was made to offer the contract through CM proposal and Alexander was awarded the project in 2001.

Contractor Selection

Contractor selection for the project was based on proposal. This process began with a request for qualifications. Alexander Constructors was then included in a list of three contractors who met the owner's determined qualifications. This was followed by a request for proposal and a proposal presentation. Alexander Constructors was awarded the project based on several factors.

- They presented a very experienced, talented team who proved capable of working well on this type of project.
- They have a local office and many contacts with local subcontractors; the architect and owner are also locally based. The Owner felt it beneficial to use all local team members to facilitate a successful project.

Project Team

OWNER	Minitab, Inc. *State College, PA*	**STRUCTURAL ENGINEER**	Comprehensive Design A/E *State College, PA*
ARCHITECT	Michael C. Haluga *State College, PA*	**HVAC DESIGN**	McClure Company *State College, PA*
CONSTRUCTION MANAGER	Alexander Constructors, Inc. *State College, PA*	**ELECTRICAL, PLUMBING & FIRE PROTECTION**	The Boyer Partnership, Inc. *Altoona, PA*
CIVIL ENGINEER	Keller Engineering *Hollidaysburg, PA*		

PROJECT DESCRIPTION

Project Information

Dates of Construction
- Preconstruction: January 2001 – June 2001
- Construction: June 2001 – November 2002
- Postconstruction: December 2002

Cost Information
(based on Design Development cost estimate)

Project Total: $10,923,477

Site Work	$1,336,373
Building Shell	$2,924,846
Interior Buildout	$2,297,258
Mechanical	$2,025,600
Electrical	$1,253,400
General Conditions	$1,086,000

Building Function and Primary Use
- Office Building

Location & Site

1829 Pine Hall Road
Ferguson Township, Centre County
State College, Pennsylvania
16.8 acre site

Architecture
- 88,000 GSF
- Four-Story
- Exposed Basement
- Full four-story atrium with glass elevators and waterfall
- 209 offices, 18 conference rooms, media room, exercise area, game room
- Landscaped walking labyrinth

Governing Codes
- Commonwealth of Pennsylvania Department of Labor & Industry
  Occupancy: D-0
  Type of Construction: Ordinary
  Building Classification: Class 1, Office Building
- 1996 BOCA National Building Code
  Use Group Classification: B (Business)
  Type of Construction: 2C (Unprotected)
  3.3 Conversion Factor; 22,000 GSF (footprint)

Project Delivery System
- Construction Management
  - CM Proposal with negotiated guaranteed maximum price

Building Envelope
- Façade: GFRC Panels – lower level
  Prefabricated panelized EIF system
- Windows: 4-foot seamless mullion, continuous glazing
- Roofing: Metal deck with 4" EPS insulation and adhered EPDM roofing

Electrical
- MDP: 4000A, 480/277V, MLO
- Generator: 350 kW, 480/277V, 3? , 4W Diesel powered emergency generator
- 35 Panelboards
- 15 – 480/277V panels
- 20 – 120/208V panels
- Large heat pumps - 480V, 3? service
- Small heat pumps - 277V, 1? , 3 per circuit (typ)

Lighting
- Primarily direct/indirect pendent hung fixtures with downlight accent lights
- Additional natural light provided by open atrium and ribbon windows
- Emergency lighting and exit signage to accommodate all applicable codes

PROJECT DESCRIPTION

Mechanical
- Geothermal heat pump system: 100 wells, each at 400 ft.
- 100% Outdoor air system
- Individual heat pump for each office, personalized temperature control

Structural
- Strip footings & spread footings, 3000 psi reinforced concrete
- 4000 psi reinforced concrete piers
- 4" 3000 psi slab on grade
- Steel frame – ASTM A572 Grade 50
- Bays 24'-4" x 19'-9"/19'-5" typ.
- Additional bracing around open four-story atrium

Fire Protection
- Advanced fire protection system
- Ionization/photoelectric detectors in telecommunication distribution rooms
- Manual fire alarms & emergency lighting
- Sprinklered in accordance with NFPA light hazard classification
- Storage areas, service rooms, and elevator rooms sprinklered according to NFPA ordinary hazard classification
- Spray-applied fireproofing of structural steel and metal deck for 2-hr rated rooms

Transportation
- Glass elevator in Garden Area/Lobby
- Freight elevator at Storage/Receiving Room
- 3 stairwells – 2 serve as means of egress

Telecommunications
- Standard telephone service system
- Main Data Service: 48-port fiber optic patch panel
- Each office has minimum of one telephone and one data outlet
- Cable television service to conference rooms, multipurpose room, theater, and employee areas

Special Systems
- Security system designed by Vigilant Security
- Key card access
- Infrared sensors throughout building

PROJECT DESCRIPTION

Project Delivery System

The delivery method of the project is a traditional type arrangement with a construction project manager. Alexander Constructors, Inc. serves as the construction manager and general contractor on the project, contractually as the CM At-Risk with a negotiated guaranteed maximum price. Alexander holds contracts with the mechanical engineer/contractor and general construction subcontractors. The Owner holds contracts with the architect, CM/GC, civil/site engineer, and the interior designer. The architect holds the contracts of the electrical/plumbing/fire protection engineer and the structural engineer. The purpose for this arrangement is to subdivide the contractual arrangements into stages of construction to facilitate fast-tracking of the project. The contractual setup for the project is outlined below.

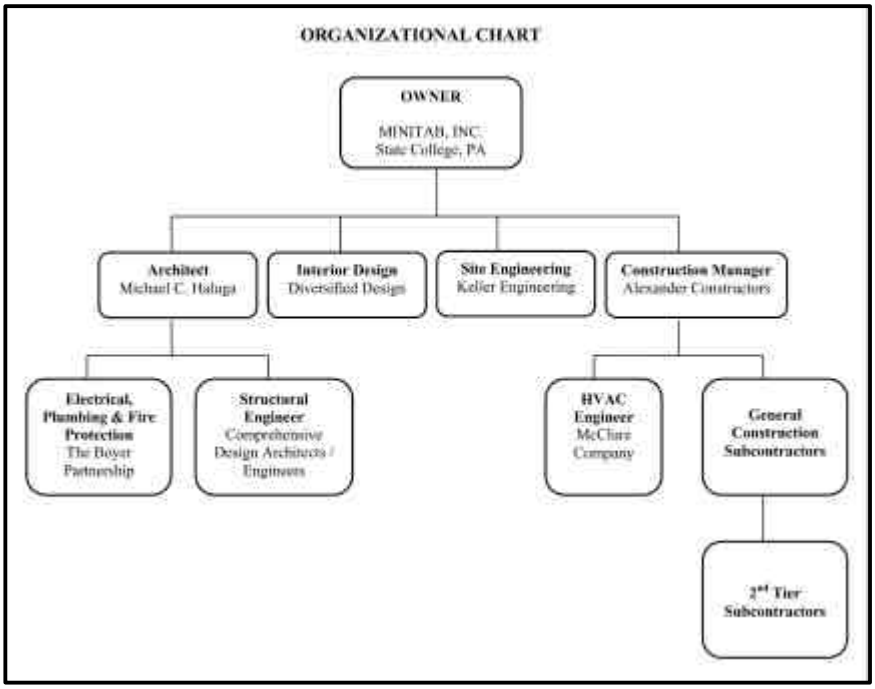

Figure 1.2 Project Contractual Organization

PROJECT DESCRIPTION

Project Schedule Summary

The project schedule is twenty-two months, with the construction phase lasting sixteen months. The interior work is to progress in a top-down manner; interior fit-out will begin on the 4th floor and progress down to the garden level (the ground floor). For purpose of producing a schedule summary, the floor breakdown is omitted from this schedule. Prefabricated EIFS panels on the exterior, coupled with 4 ft. ribbon windows, are the key element to pay attention to on the schedule. Panels must be fabricated and delivered to site in close coordination with the rate of work that the crew is doing. The panels should not be stored on site for long periods of time and neither should the crew be held up waiting for delivery. On site alteration to the prefab panels is difficult and, as this is a fairly new approach, some problems are expected. Also of concern in this regard is that installation of the EIFS panels is to begin in the middle of January. Weather may be a hindrance to the timely installation of the panels (Figure 1.3).

PROJECT SCHEDULE SUMMARY

Description	Duration	Start Date
PRE-CONSTRUCTION PHASE		
Schematic Design/Design Development	40	02JAN02
Design Approval	60	13MAR01
Approvals & Permits	110	21JUN01
CONSTRUCTION PHASE		
SITE		
Preliminary Site Work	120	29JUN01
Finish Site Work	165	21AUG02
STRUCTURE AND EXTERIOR SKIN		
Excavation	60	26JUN01
Footings & Foundations	50	20AUG01
CMU @ stairs	95	21SEP01
Underslab Roughin	35	21SEP01
Prep & pour slab on grade	40	10OCT01
Erect structural steel	40	12NOV01
Erect floor decking	35	15NOV01
Pour slab on deck	25	05DEC01
Erect roof deck	5	09JAN02
Install prefab EIFS panels	45	22JAN02
CMU @ elevator shaft walls	60	11MAR02
Windows	50	18MAR02
Install elevators	70	17APR02
Roofing	95	04JAN02
INTERIOR FITOUT		
MEP Roughins	150	19DEC01
GWB soffits/acoustical ceiling grid	115	18MAR02
Drywall	105	19MAR02
Paint walls & soffits	70	13MAY02
Door frames, doors/hardware/casework	55	14JUN02
MEP Trimout	80	17JUN02
Floor coverings	30	12AUG02
Preliminary punchlist	25	11SEP02
COMMISIONING AND FF&E		
FF&E Selection and install	205	21DEC01
Testing and balancing	45	22AUG02
Final punchlist / substantial completion	5	22OCT02
Owner Occupancy	5	29OCT02

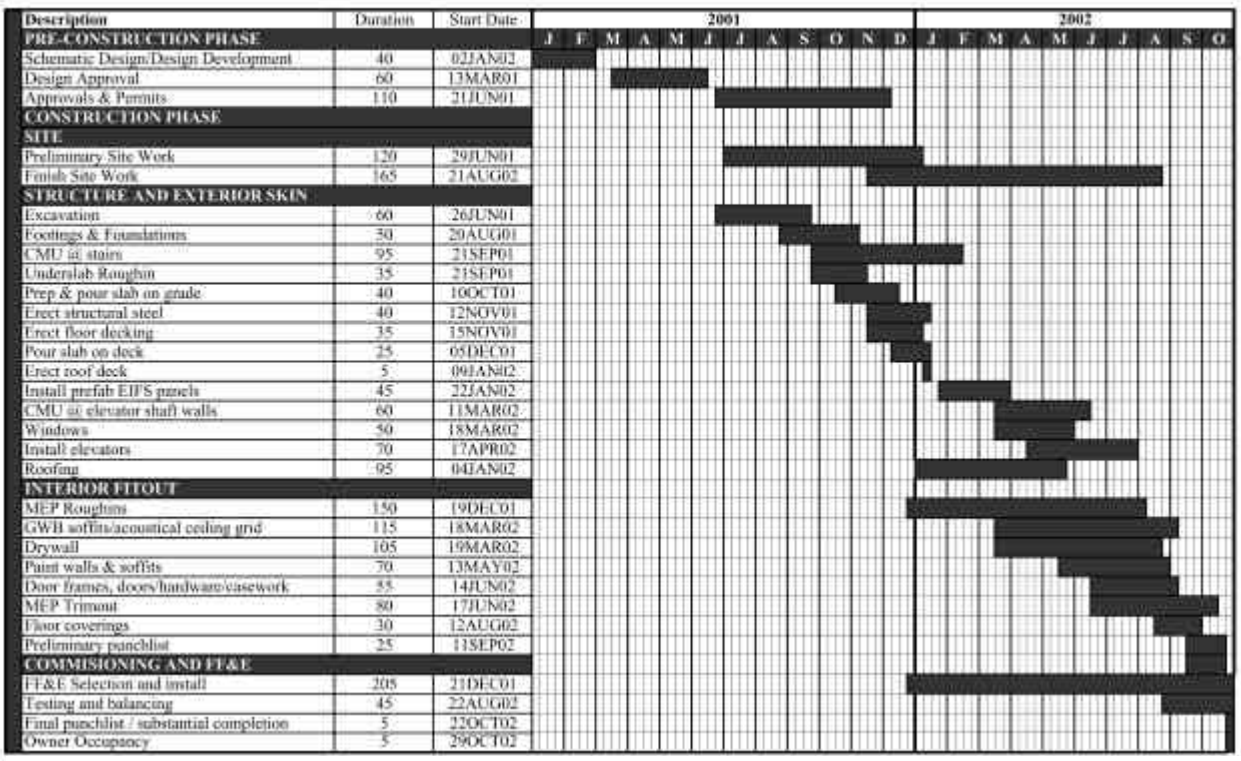

Figure 1.3 Project Schedule Summary *(full 11x17 schedule in Appendix C)*

PROJECT DESCRIPTION

Site Plan

The project location is a 16.8 acre site about 2 miles West of State College, Pennsylvania just off Science Park Road in Ferguson Township. The plot chosen for Minitab, Inc. was undeveloped and posed little restriction in terms of construction site layout, with a building footprint of 22,000 SF or 0.5 acres, there are many options as to layout of the site plan. Shown below is a general layout; including site access, job site trailers, parking, crane locations, and steel staging areas.

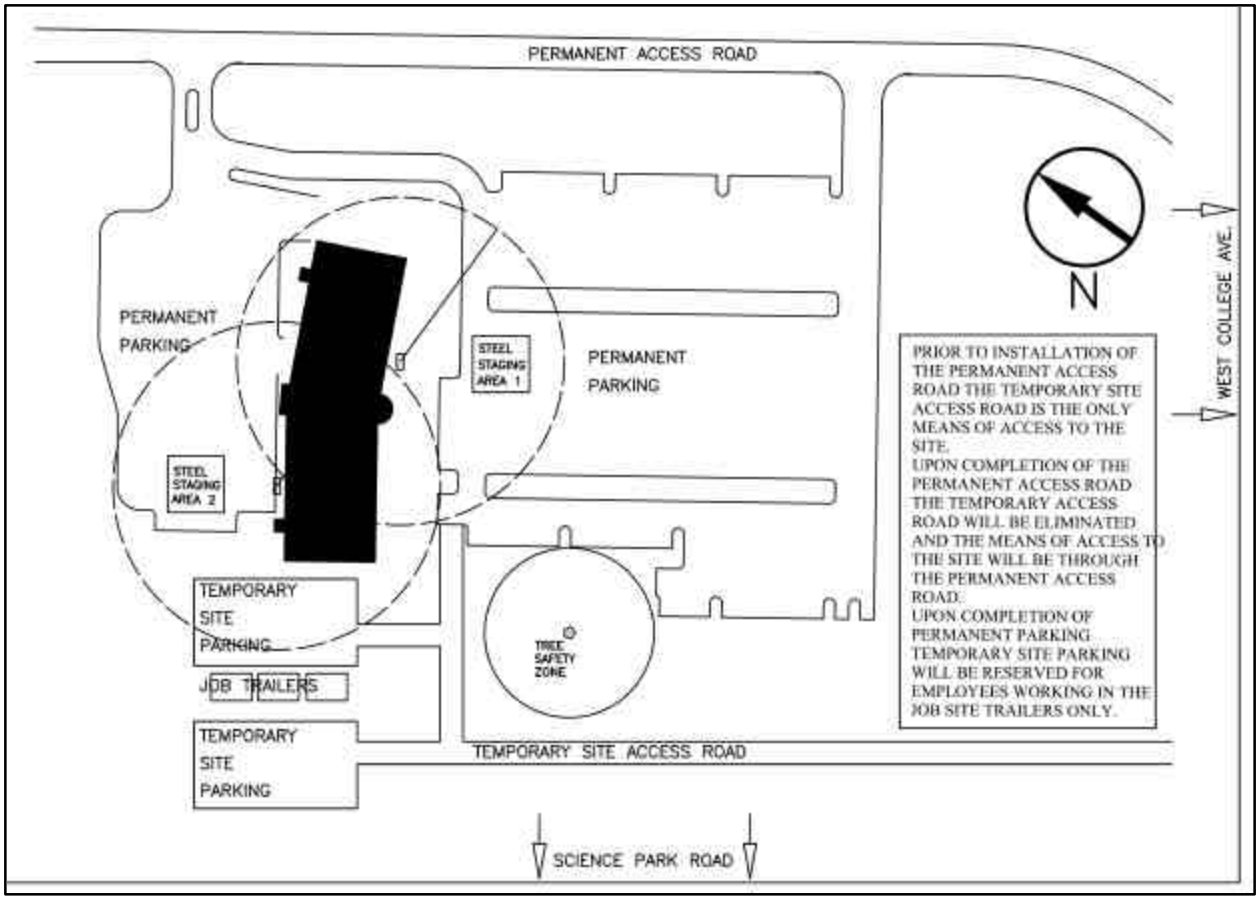

Figure 1.4 Site Plan

SECTION 2
CLADDING SYSTEM

Exterior Insulation Finish Systems
Precast Concrete Curtain Wall Panel
Life Cycle Cost Analysis
Structural Impact of Cladding System
Schedule Analysis of Cladding System

SECTION 2: CLADDING SYSTEM

An analysis was conducted to compare the current EIFS exterior cladding system to the use of a precast concrete panel system. The purpose of this analysis is to investigate the life cycle costs, determine the maintenance schedule and associated costs, and provide a best value analysis.

Economics plays a major role in the choice of building products and systems. Criteria that must be considered include the following:

- Type/use of building
- Desired appearance
- Economic performance
- Building location
- Local trends & conditions

Type/use of Building

Minitab Headquarters is a commercial office building.

Desired Appearance

A clean line is the goal for the exterior appearance of the building. Seamless mullion ribbon windows and a smooth finish cladding system provide a neat, clean façade.

Economic Performance

Minitab, Inc. desired an efficient building. Therefore, they chose to use an exterior insulation system to minimize thermal breaks and minimize heat loss through the exterior walls. Redesign of the exterior system must maintain the R-value of the wall to ensure that the building maintains its current thermal efficiency.

Building Location

The building is located in State College, Pennsylvania.

Local Trends & Conditions

Exterior insulation finish systems are the most used exterior cladding system in commercial construction and this holds true in State College as well. The climate is fairly moist, especially from November through April.

CLADDING SYSTEM

Exterior Insulation Finish Systems

Exterior insulation finish systems (EIFS) were first introduced to the commercial sector in the United States over thirty years ago. Today they are the most widely used exterior cladding in commercial construction, making up nearly thirty percent of the market. EIFS Industry Members Association (EIMA) defines EIFS as follows:

> *A non-load bearing exterior wall cladding system consisting of an insulation board, an adhesive and/or mechanical attachment of the insulation board to the substrate, and an integrally reinforced base coat on the face of the insulation board, a protective finish applied to the surface of the base coat and applicable accessories that interact to form an energy efficient exterior wall.*

Exterior insulation finish systems offer a number of benefits over other cladding systems. EIFS provide exceptional energy efficiency by providing a thermal blanket for the building. Air infiltration is reduced by as much as fifty-five percent over cladding systems such as masonry and stone. By placing insulation on the exterior of the building, thermal breaks are substantially minimized, the interior environment is stabilized, and energy consumption is reduced. Thus, lower-capacity heating and cooling equipment can often be specified. EIFS provide great design flexibility. Ornate detailing can be achieved that would be cost prohibitive with other systems. The finish can be applied to suit the intent of the design, ranging from a smooth finish to rough stucco like texture and is available in a wide color spectrum. The benefits of the use of EIFS result in increased market share each year.

EIFS has received a bad reputation in the past due to susceptibility to moisture infiltration and resulting damage to the system. The key to performance of an EIF system is proper attention paid to design, detail, and installation. For these reasons, EIFS has performed well in commercial applications since each stage from design through construction is monitored by industry professionals. As a quality assurance measure, a requirement for most projects is a mock-up of the system that includes all major elements of the wall assembly, interfaces with windows and penetrations, sealants and expansion joints, flashing, etcetera. The efforts of professionals in the commercial construction industry have led to the successful use of EIFS.

CLADDING SYSTEM

Precast Concrete Curtain Wall Panel

Precast concrete offers one of the most durable and cost efficient exterior claddings on the market. Precast offers the same benefits as the EIFS exterior without the reputation for moisture problems. Precast has virtually unlimited design possibilities. The concrete can be color infused and textured to achieve the desired finish effect. Rigid insulation is attached to the precast, providing the building with an exterior thermal barrier in order to maintain the insulating properties of the current design. The benefits to the use of precast is that it is low maintenance and is not vulnerable to moisture. It is resistant to moisture, rot, insects, fire and general wear. The use of precast can achieve the design criteria set forth for this project.

Figure 2.1 Precast concrete panel finish appearance.
(Houston Co. Spec., Perry, GA – Tindall Corporation)

Life Cycle Cost Analysis

As discussed in the above sections, both precast and EIFS have the ability to provide the desired finished effect for the Owner. In order to provide an accurate best value analysis a life cycle cost analysis for building systems including all relevant expenses for the building or building system must be factored into the analysis, including:

- Installation
- Maintenance & Repair
- Energy savings*
- Inflation

* *Energy savings is not calculated in the life cycle cost analysis due to the fact that in comparison of the two cladding systems an equal R-value was provided.*

The life cycle cost analysis for EIFS and precast concrete panels is based on methods and factors provided by *ASTM Standard Practice for Measuring Life Cycle Costs of Buildings and Building Systems*. For life cycle cost calculations, please refer to Appendix A at the end of this document.

The cost analysis is based on a thirty year study period. This period was chosen to be representative of maintenance schedules that will cycle after the thirty year period. Since EIFS has only been in use in the U.S. for approximately thirty years, it is difficult to determine maintenance requirements past this time frame. Many references suggest that at this point the entire EIFS façade may require replacement. For the purpose of this study, the life cycle analysis is limited to thirty years so that reliable data could be utilized and maintenance projections could be quantified.

Based on an exterior façade area of 23,000 SF the initial installation cost for the Class PB exterior insulation and finish system is $344,761. The assembly includes metal stud framing, cavity fiberglass batt insulation, 4 in. EPS insulation, and EIFS finish coating materials. Thirty year maintenance costs include cleaning of 100% of the EIFS at fifteen years at a time adjusted cost of $7,318 and cleaning and recoating at thirty years at an adjusted cost of $11,119. The total thirty-year life cycle cost estimate is $363,198.

CLADDING SYSTEM

Also based on 23,000 SF the initial installation cost for the precast concrete curtainwall panels is $275,377; a $69,384 initial cost savings to EIFS. The assembly includes non-loadbearing metal studs at 16 in. on center, cavity fiberglass batt insulation, flat precast concrete panel with 2 in. of rigid insulation, and an additional 2 in. of rigid insulation to equal the insulating value of the EIFS with an R-20. Recommended maintenance includes recaulking the panels at twenty years for an adjusted cost of $30,925 and cleaning at year 25 for an adjusted cost of $6,183. The total thirty-year life cycle cost estimate for precast panels is $303,639; a $59,559 savings to the EIF system.

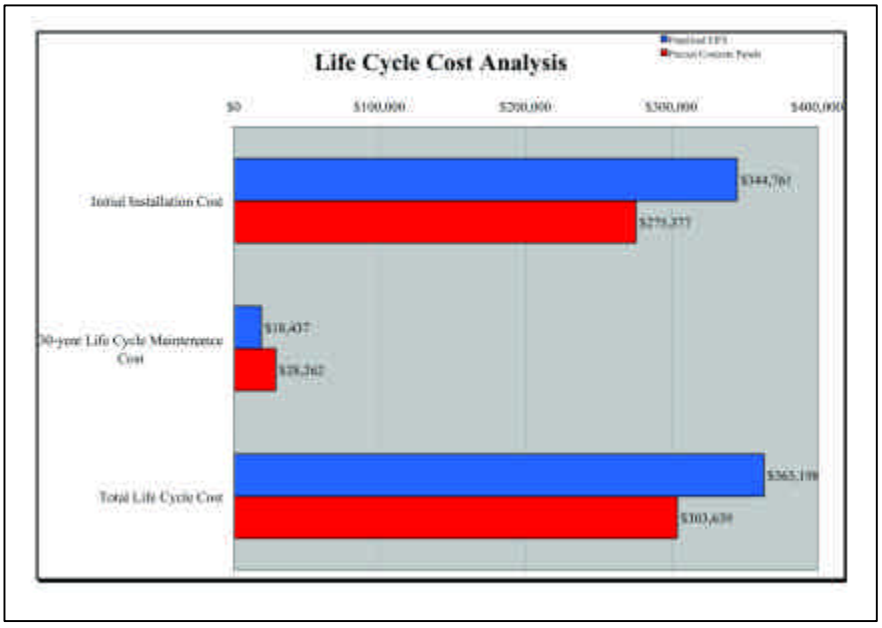

Figure 3.1 Thirty-year life cycle cost estimate of cladding systems – EIFS and precast concrete curtain wall system.

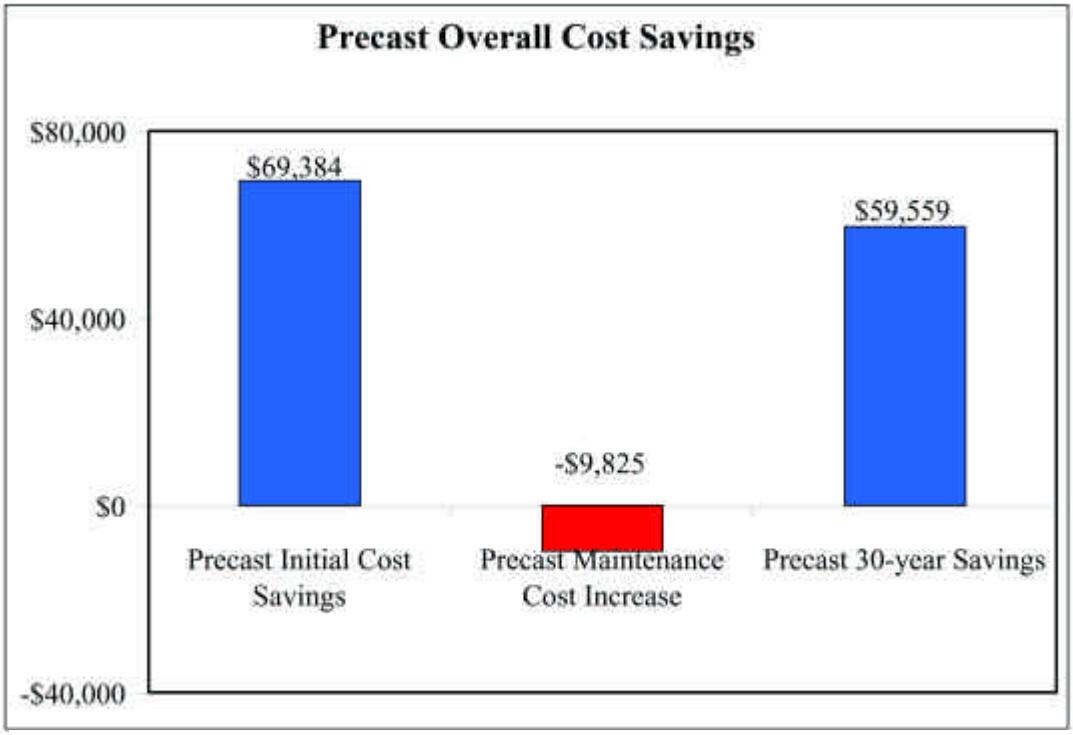

Figure 3.2 Life cycle cost savings of precast curtain wall system to EIF system.

Structural Impact of Cladding System

The structural frame of the building is bays which are typical 24'-0"x19'-9"/19'-5" (see 'Typical Structural Frame' Appendix B). The EIFS panels are connected to the perimeter beams by angles; shown in Figure 3.3. The precast panels are attached in a similar manner, but are only connected to the perimeter columns of the frame. Each panel spans the perimeter columns and therefore does not impose load on the beams. For purpose of a simplified structural analysis, a typical panel size of 24'-0" x 7'-3" was used. The weight of the EIFS panel includes 4 in. expanded polystyrene rigid insulation, heavyweight reinforcing mesh, and 20 ga., 6 in. metal studs at 16 in. on center for a total weight of 581 pounds per panel. The weight of the precast panel includes 4 in. expanded polystyrene rigid insulation and 6 in. lightweight concrete (50 pcf) for a total weight of 4,408 pounds per panel. The precast panel is 3,827 pounds heavier than the EIFS; the overall weight increase per bay with three panels per span is 11,481 pounds.

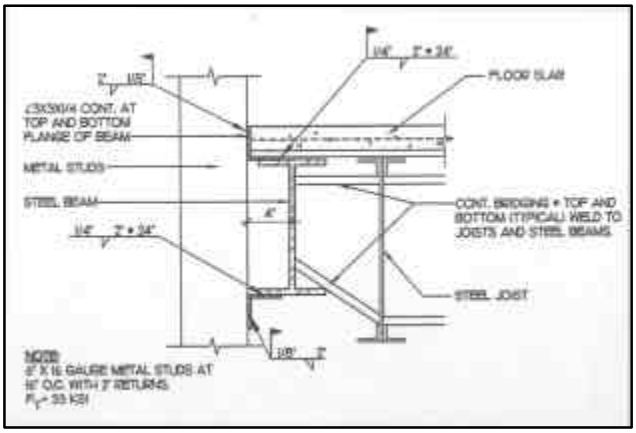

Figure 3.3 EIFS Panel Connection Detail

TABLE 3.1 *Panel Weight*

Cladding Assembly	Panel Size	Weight (per Panel)
EIFS Panel - 4 in. EPS insulation - Heavyweight reinforcing mesh - 20 ga., 6 in. metal studs @ 16" o.c.	24'-0" x 7'-3"	581 lbs.
Precast Panel - 6 in. lightweight concrete (50 pcf) - 4 in. EPS insulation	24'-0" x 7'-3"	4,408 lbs.

A structural analysis of the weight increase effect on the perimeter columns is included in Appendix B. Loading calculations include a tributary area of 242 sq.ft. with a total design load

increase of 8%; 13,777 pounds per bay. The total design load for the columns with the use of precast is 184 kips. The current steel frame design is W12x45 perimeter columns with a design load of 350 kips. To accommodate the increased load, the perimeter columns should be increased to a W12x50 with a design load of 393 kips; an increase in design load of 12.3%. There are thirty perimeter columns, each 38 feet in length, which will be up-sized by 5 lb/lf. The additional steel is 5,700 lbs. Based on the original GMP estimate, steel is $1,420/ton; for a total increase in structural steel of $4,047.

The adjusted installation cost savings of the precast system is $65,337 and the life cycle cost savings is $55,552.

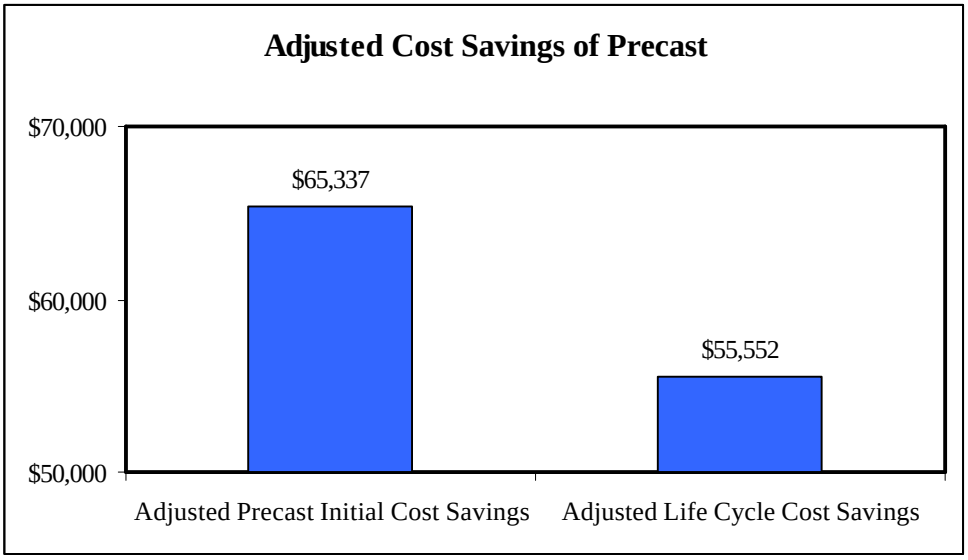

Figure 3.4 Adjusted precast cost savings.

Schedule Analysis of Cladding Systems

The activity prior to exterior cladding is erection of the structural steel. Immediately following the completion of the steel structure, installation of the prefabricated EIFS panels begins. These activities are both on the critical path as they directly effect the project schedule duration. Both the EIF system and the precast panel system require a total of fifty panels. Any time that can be saved in erection of the cladding system will result in potential early project completion. Figure 3.5 shows the original project schedule summary.

PROJECT SCHEDULE SUMMARY

Description	Duration	Start Date
PRE-CONSTRUCTION PHASE		
Schematic Design/Design Development	40	02JAN02
Design Approval	60	13MAR01
Approvals & Permits	110	21JUN01
CONSTRUCTION PHASE		
SITE		
Preliminary Site Work	120	29JUN01
Finish Site Work	165	21AUG02
STRUCTURE AND EXTERIOR SKIN		
Excavation	60	26JUN01
Footings & Foundations	50	20AUG01
CMU @ stairs	95	21SEP01
Underslab Roughin	35	21SEP01
Prep & pour slab on grade	40	10OCT01
Erect structural steel	40	12NOV01
Erect Decking @ 1st Floor	4	15NOV01
Erect Decking @ 2nd Floor	4	03DEC01
Slab on Deck - 1st Floor	4	05DEC01
Erect Decking @ 3rd Floor	4	21DEC01
Slab on Deck - 2nd Floor	4	21DEC01
Slab on Deck - 3rd Floor	4	04JAN02
Erect Roof Deck	5	09JAN02
Roofing	95	04JAN02
Prefabricated EIFS Panels South Wall	18	22JAN02
Prefabricated EIFS Panels West Wall	12	22JAN02
Prefabricated EIFS Panels North Wall	18	28JAN02
Prefabricated EIFS Panels East Wall	12	04MAR02
CMU @ elevator shaft walls	60	11MAR02
Windows Exterior West Wall	8	18MAR02
Windows Exterior North Wall	15	21MAR02
Windows Exterior South Wall	23	25MAR02
Windows Exterior East Wall	8	26MAR02
Install elevators	70	17APR02
INTERIOR FITOUT		
MEP Roughins	150	19DEC01
GWB soffits/acoustical ceiling grid	115	18MAR02
Drywall	105	19MAR02
Paint walls & soffits	70	13MAY02
Door frames, doors/hardware/casework	55	14JUN02
MEP Trimout	80	17JUN02
Floor coverings	30	12AUG02
Preliminary punchlist	25	11SEP02
COMMISIONING AND FF&E		
FF&E Selection and install	205	21DEC01
Testing and balancing	45	22AUG02
Final punchlist / substantial completion	5	22OCT02
Owner Occupancy	5	29OCT02

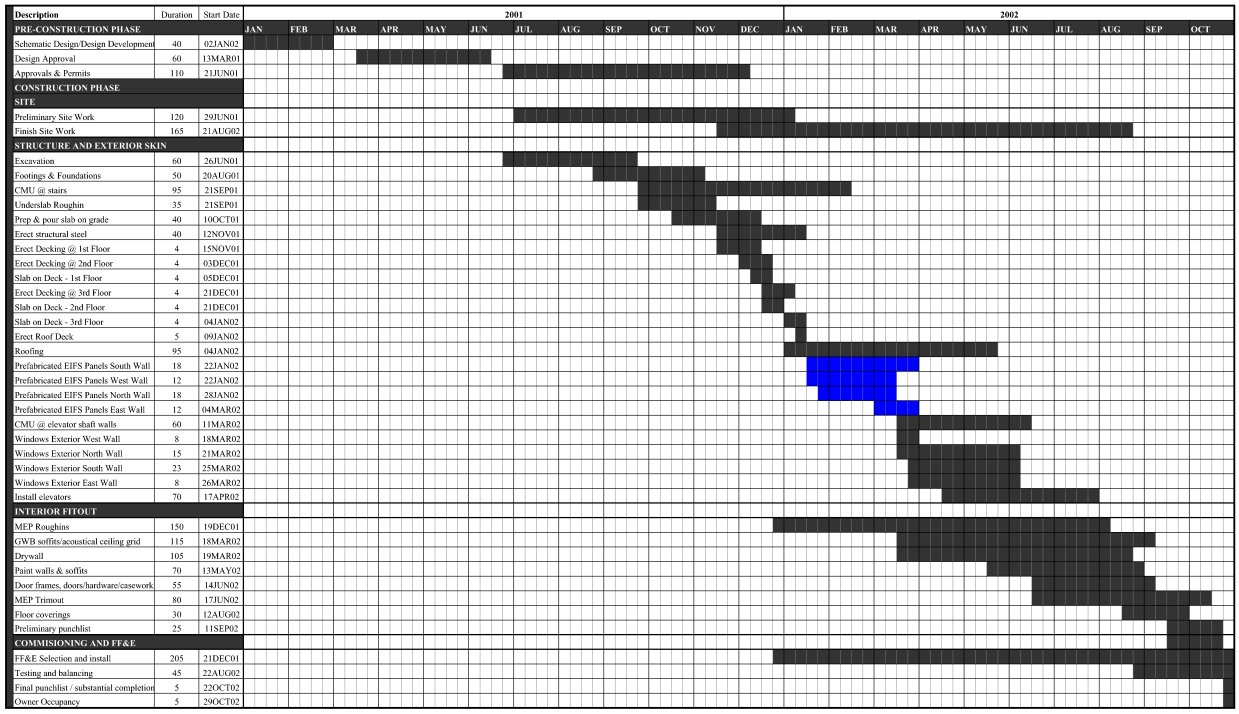

Figure 3.5 Original Project Schedule Summary *(11x17 format in Appendix C)*

CLADDING SYSTEM

Schedule Analysis: Exterior Insulation Finish System

The schedule duration for the erection of the prefabricated EIFS panels is forty-eight days, an average of one panel per day. Originally it was planned to use the cranes that were used for the steel erection for EIFS panel installation. The installers found it more feasible to use a telescoping fork lift to hoist the panels into place and devised an attachment rigging. With each panel weighing only 581 pounds, the fork lift was able to perform this task with ease. The procedure for hoisting the panels is depicted below with the installation of the first panel.

Figure Prefabricated EIFS panels were hoisted into place with a special rigging attached to a fork lift. An average of 1 panel per day was raised by this method.

Though the actual schedule duration indicates a production rate of one panel per day, according to an activity duration analysis the crew will be installing eight panels per day. This is based on best case scenario. For purpose of accurate comparison, it is estimated that six panels per day will be installed using the fork lift method. Resulting in a total activity duration of nine days.

Panelized EIFS Installation Detail

ACTIVITY	DURATION
1. Attached panel to fork lift rigging.	10 min.
2. Maneuver forklift to panel installation location.	5 min.
3. Align panel with pre-installed steel angle attachments.	15 min.
4. Level and attach panel to structural steel frame.	30 min.
TOTAL EIFS PANEL INSTALLATION DURATION (per panel):	1 hour
TOTAL ACTIVITY DURATION:	**9 DAYS**

EIFS
ACTIVITY SCHEDULE

Description	Duration	NOV	DEC	JAN	FEB
Erect structural steel frame	40				
Prefabricated EIFS Panels	9				
Windows - Exterior	8				

CLADDING SYSTEM

Schedule Analysis: Precast Concrete Curtain Wall Panels

Weighing in at just over 4,400 pounds, it is not conceivable to use a fork lift to hoist the precast panels into place. Therefore, the cranes used to erect the steel must remain to erect the precast panels. The process for erecting the precast panels is much the same as the procedure used for the EIFS panels. Each panel will be lifted from the staging area and maneuvered to the installation location. The panels are attached to the perimeter columns with steel angles welded to the columns and steel clips embedded in the precast. Based on a production rate of 2.25 hours per panel (see table), the duration to install 50 panels is nineteen days.

Precast Panel Installation Detail

ACTIVITY	DURATION
1. Attached panel to crane rigging.	15 min.
2. Maneuver panel to installation location.	30 min.
3. Align panel with pre-installed steel angle attachments.	30 min.
4. Level and attach panel to structural steel frame.	60 min.
TOTAL EIFS PANEL INSTALLATION DURATION:	2.25 hours
TOTAL ACTIVITY DURATION:	**19 DAYS**

PRECAST PANEL ACTIVITY SCHEDULE

Description	Duration	NOV	DEC	JAN	FEB
Erect structural steel frame	40				
Precast Panels	19				
Windows - Exterior	8				

Summary of Activity Duration for Alternate Cladding Systems

Cladding System	Production Rate	Number of Panels	Total Activity Duration
EIFS Panels	**1.0 hour/panel**	**50**	**9 days**
Precast Panels	**2.25 hour/panel**	**50**	**19 days**

Alternate Cladding Systems Analysis Conclusions

Analyses conducted to compare the current EIFS exterior cladding system to the alternate use of a precast concrete panel system result in a first cost savings of $69,384. Precast panels' thirty year life cycle cost analysis yield maintenance costs of $28,262 while the maintenance costs over a thirty year period for EIFS are calculated at $18,437. Thus, based on life cycle cost analysis, the cost saving for using the alternate precast panel system is $59,559. The use of precast panels results in an increased curtainwall load of 13,777 pounds per structural bay; an overall increase in structural steel required of 2.85 tons or $4,047. The result is a decrease in first cost savings to $65,337. An overall life cycle cost savings of $55,512, a 16% savings on the exterior cladding budget and a 0.5% savings on the project estimated cost. Schedule impact of using the precast panel system results in an activity duration extension for the exterior cladding of ten days. The overall project schedule will be extended due to the fact that the cladding activity is on the critical path of the project. A ten day extension in time may be compensated by the substantial cost savings and it is possible that this time will be made up in other areas of construction. Precast concrete offers superior durability and moisture protection. Coupled with the associated cost savings, precast is a preferable system to utilize for the exterior cladding of Minitab Headquarters.

SECTION 3
MECHANICAL SYSTEM

Original Design: DOAS

Redesign: Geothermal System

SECTION 3: MECHANICAL SYSTEM

The original mechanical system designed by the MEP engineer was a Dedicated Outdoor Air System (DOAS) with a parallel radiant panel system. A problem arose with the original design; the engineer did not consider the structural loads imposed by the boiler and chiller located on the roof. Due to the small size of the mechanical room, it was not considered feasible to alter the building layout to accommodate the boiler and chiller. An option was to locate the equipment on the roof, but the structural system was not designed for the imposed load and this also would require redesign. The Engineer's conceptual estimate for the radiant panel system was $1.5 million and did not include the added impact of redesigning the structure, a cost increase of approximately $200,000 including design, material, and installation costs. The Owner chose to investigate other possibilities for the mechanical system. An alternate design-build mechanical contractor was called in by the Owner and Construction Manger to verify the mechanical budget. The Contractor concluded that a geothermal system could be installed for the same cost as the original design and would not require building layout or structural redesign, therefore making it less expensive by comparison. There is adequate space on the site to accommodate the geothermal well field. The Owner chose to utilize this space as opposed to making alterations to the building design. Based on this review, the contractor was retained as the mechanical design-builder to implement a ground-source geothermal system.

A geothermal system offers similar benefits to the original radiant panel design and fulfills the Owner's objectives, including minimal noise levels and local user control. A geothermal heating system was chosen due to its energy-efficiency, minimal equipment space requirements, minimal maintenance, and environmentally friendly operation. The project site is conducive to a geothermal system; the site is seventeen acres which provides adequate field space for the system. The total cost of the system is $1.5 million and consists of a geothermal heat pump system with 100 wells each drilled to 400 feet, a 100% outdoor air system and individual heat pumps for each office providing local control; 278 heat pumps were installed above the ceiling in the corridor. By providing each office with a heat pump and thermostat, each employee is able to

adjust their work environment to meet their personal comfort level, resulting in increased productivity.

Design Build Mechanical Contractor

Employing a design-build mechanical contractor facilitated fast-tracking the system installation. Design-build combines responsibility for design and construction into one single source minimizing communication conflicts and provides fluidity through design and construction. Conflicts that potentially arise between the entities of design and construction which lead to field conflicts are essentially eliminated. The design-build mechanical contractor has a greater ability to provide the system on time and within budget than is possible with a dual responsibility arrangement.

Original Design: Dedicated Outdoor Air – Radiant Panel System

The original mechanical system designed by the MEP engineer was a Dedicated Outdoor Air System (DOAS) with a parallel radiant panel system. A radiant panel heating/cooling system operates by heat transfer between the space and the radiant panels through a temperature differential in the space. Radiant panels address a majority of the sensible heat (temperature) and are used in conjunction with a ventilation system designed to provide additional temperature control, maintain air quality and, control latent (moisture) load. A general schematic of the system is shown in Figure 3.1 (Stein, 2000).

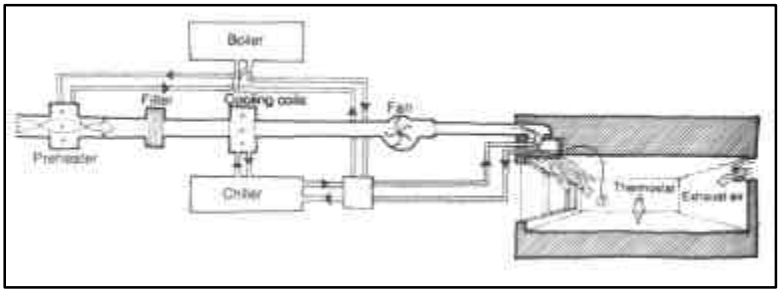

Figure 3.1 General schematic radiant panels with supplementary air.

The combination air-water system distributes sensible loads and reduces noise through a reduction in air velocities and duct sizes. The system also provides local user control by means of an electronic or digital thermostat control and an on/off valve for each zone. The use of a combined system for both heating and cooling reduces necessary equipment and minimizes piping compared to conventional systems that require both heating and cooling components.

Redesign: 100% Outdoor Air – Geothermal System

Ground source heat pumps are the most energy-efficient, environmentally clean, and cost effective space conditioning system available according to the Environmental Protection Agency (EPA). A geothermal heat pump works in much the same way as a refrigerator or freezer. Heat is transferred from a low temperature medium to a high temperature medium. Refrigerant is circulated through underground pipe loops. In the heating cycle, heat is extracted from the soil and rejected to the building space. In the cooling cycle, the process is reversed and heat is removed from the air and the refrigerant rejects the heat to the soil.

The geothermal system designed for Minitab is a vertical ground source closed loop heat pump system consisting of the following:

- 40,000 lf of pipe – 100 wells @ 400 ft. each
- 278 high-efficiency heat pumps
- Air to air heat recovery systems between the exhaust and outdoor air streams

Figure 3.2 Individual heat pumps for each office above the ceiling in the corridor.

Figure 3.3 Geothermal Well Field

Mechanical System Analysis Conclusions

The original mechanical system designed by the MEP engineer was a Dedicated Outdoor Air System (DOAS) with a parallel radiant panel system. Based on additional estimated costs of $200,000 incurred to redesign building layout and structural frame increase to locate a boiler and chiller on the roof to service the system, the Owner chose to investigate other possibilities for the mechanical system. An alternate design-build mechanical contractor ascertained that a geothermal system could be installed for a cost equivalent to the original DOAS design. The Owner chose to utilize available space on site, rather than impede the current building layout, to install a geothermal well field for a ground-source heat pump system. The new system meets the load requirements set by the prior system and results in a cost savings of $200,000.

Mechanical System	Original Estimated Cost	Total System Installation Cost
DOAS	$ 1.5 M	$ 1.7 M
Geothermal	$ 1.5 M	$ 1.5 M

Table 3.1 Summary of the effects of implementing a geothermal system instead of the original DOAS design.

SECTION 4
GREEN BUILDING

SECTION 4: GREEN BUILDING

Green Building

A study was conducted to determine the possibilities of Minitab pursuing credits to achieve a LEED™ rated building. Minitab prides itself on being a satisfying and enjoyable place to work. Green building possibilities echo the environmental and human health consciousness of the company. According to Minitab, "We hire the best people and then provide them with an environment that enables them to do their best work." As a reward for their effort to provide a superior working environment, Minitab was voted "#1 Best Places to Work in PA" in 2002 in the category of medium-sized companies (fifty to two-hundred fifty employees). The focus of their effort is to provide an atmosphere conducive to employee health, quality of life, and productivity.

Benefits of an Environmentally Smart Office Building

The effort put forth to design and construct an earth and occupant friendly building brings about long term benefits to the environment, building occupants, and future generations. Designing for a green building includes the following parameters: energy efficiency, technology advances, indoor air quality, waste minimization, thermal comfort, resource efficiency, protection from liability issues, increase property value, accelerated depreciation opportunity, and reduced insurance premiums. Significant gains in worker health create improved satisfaction which leads to increase productivity, higher profits, and decreased employee turnover.

Minitab Headquarters as a LEED™ Rated Building

LEED™ certification involves point awards in six major categories with a total available point draw of sixty-nine as follows:

Category	Possible Points
1. Sustainable Sites	14
2. Water Efficiency	5
3. Energy and Atmosphere	17
4. Materials and Resources	13
5. Indoor Environmental Quality	15
6. LEED Innovation Credits	5
TOTAL:	**69**

GREEN BUILDING

Points Category	Description of Possible Points	Possible Points	Total Points for Category
Sustainable Sites	Bicycle storage & changing rooms	1	**3**
	Parking Capacity	1	
	Stormwater Management	1	
Water Efficiency	Water Efficient Landscaping: Reduce by 50%	1	**4**
	Water Efficient Landscaping: No potable use or No irrigation	1	
	Water Use Reduction: 20% reduction	1	
	Water Use Reduction: 30% reduction	1	
Energy & Atmosphere	Fundamental Building Systems Commissioning	Required	**2-11**
	Minimum Energy Performacne	Required	
	CFC Reduction in HVAC&R Equipment	Required	
	Optimize Energy Performance	1-10	
	Additional Commissioning	1	
Materials & Resources	Storage & Collection of Recylables	Required	**2**
	Construction Waste Management: divert 50%	1	
	Regional Materials: 20% manufactured locally	1	
Indoor Environmental Quality	Minimum IAQ Performance	Required	**9**
	Environmental Tobacco Smoke (ETS) Control	Required	
	Construction IAQ Management Plan: During Construction	1	
	Construction IAQ Management Plan: Before Occupancy	1	
	Low-Emitting Materials: Adhesives & Sealants	1	
	Low-Emitting Materials: Paints & Coatings	1	
	Low-Emitting Materials: Carpet	1	
	Low-Emitting Materials: Composite Wood	1	
	Thermal Comfort: Comply with ASHRAE 55-1992	1	
	Thermal Comfort: Permanent Monitoring System	1	
	Daylight & Views: Daylight 75% of spaces	1	
Innovation & Design Process	Innovation in Design	1-4	**1-4**
		TOTAL POSSIBLE LEED POINTS:	**22 - 33**

Table 4.1 Likely categories for Minitab to gain points for LEED Certification.

LEED™ Certification of Minitab Headquarters

Total points required to achieve a LEED Certified level is 26-32. Minitab Headquarters would achieve the Certified level by pursuing points as outlined in Table 4.1. Minitab falls into two of the leading categories for LEED certification – commercial office buildings make up the largest category of all registered buildings and profit corporations make up the largest category of owner type. Minitab is an environmentally conscious corporation and achieving LEED certification would benefit them from the increased respect from the public in the State College area and increased employee morale in the pride to work for an environmentally conscious company.

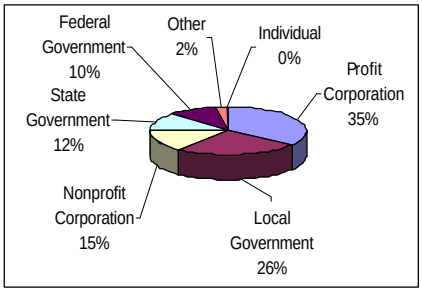

Figure 4.1 Category of registered LEED buildings by Owner type percentage. (USBGC)

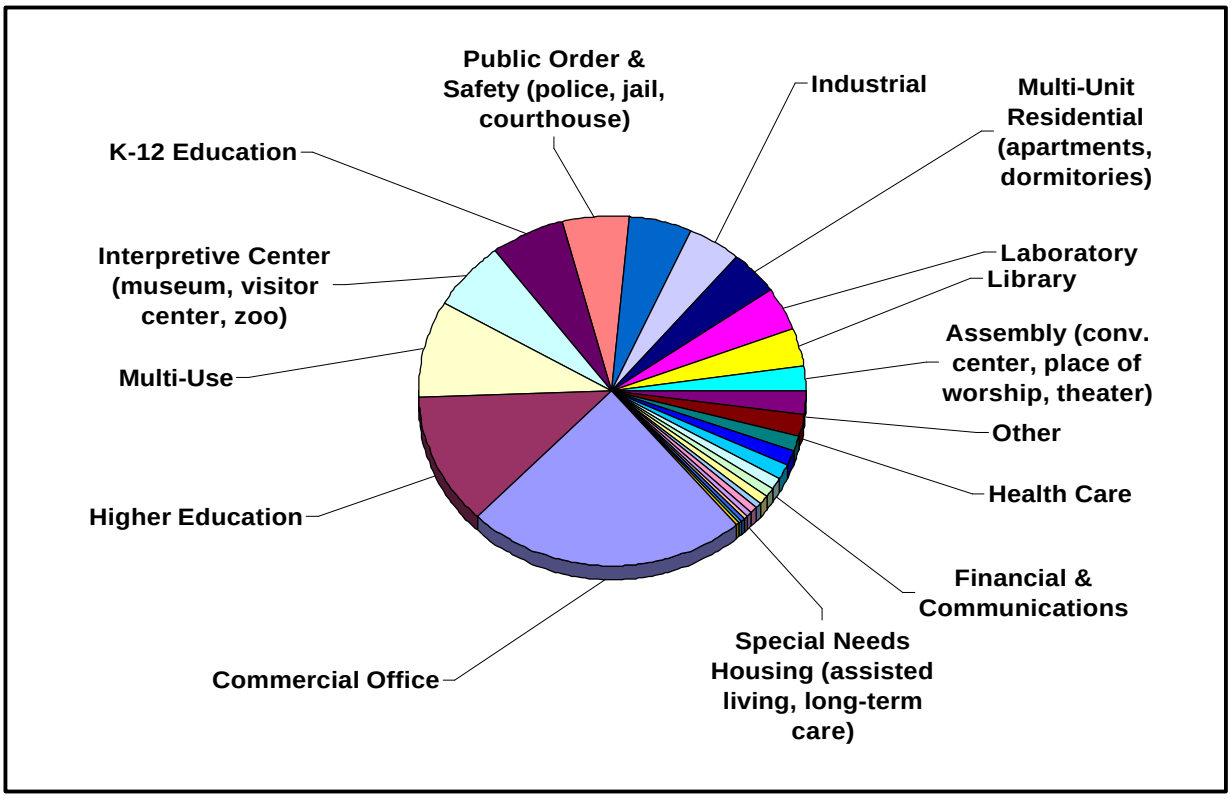

Figure 4.2 Category of registered LEED buildings by building type. (USGBC)

Green Building Analysis Conclusions

Minitab prides itself on being a satisfying and enjoyable place to work. Green building possibilities echo the environmental and human health consciousness of the company. The focus of their effort is to provide an atmosphere conducive to employee health, quality of life, and productivity. LEED™ rating system points categories investigated to offer areas and processes where Minitab may able to accumulate points toward certification proves that with a minimal amount of increased preconstruction planning Minitab would achieve a certified green building. Associated benefits of achieving LEED™ certification include significant gains in worker health, improved satisfaction which leads to increase productivity, higher profits, and decreased employee turnover; which ultimately add value to the building.

SECTION 5: CONCLUSIONS

Analyses conducted to compare the current EIFS exterior cladding system to the alternate use of a precast concrete panel system result in a first cost savings of $69,384. Precast panels' thirty year life cycle cost analysis yield maintenance costs of $28,262 while the maintenance costs over a thirty year period for EIFS are calculated at $18,437. Thus, based on life cycle cost analysis, the savings for using the alternate precast panel system are $59,559. The use of precast panels results in an increased curtainwall load of 13,777 pounds per structural bay; an overall increase in structural steel required of 2.85 tons or $4,047. The result is a decrease in first cost savings to $65,337 and an overall life cycle cost savings of $55,512. Precast concrete offers superior durability and moisture protection. Coupled with the associated cost savings, precast is a preferable system to utilize for the exterior cladding of Minitab Headquarters.

The original mechanical system designed by the MEP engineer was a Dedicated Outdoor Air System (DOAS) with a parallel radiant panel system. A geothermal heat pump system replaced the original system based on constructability issues that arose in the design process of the DOAS system. A cost savings of approximately $200,000 resulted from implementation of the alternate geothermal system.

A study was conducted to determine the possibilities of Minitab pursuing credits to achieve a LEED™ rated building. Minitab prides itself on being a satisfying and enjoyable place to work. Green building possibilities echo the environmental and human health consciousness of the company. The focus of their effort is to provide an atmosphere conducive to employee health, quality of life, and productivity. LEED™ rating system points categories are investigated to offer areas and processes where Minitab may able to accumulate points toward certification. Associated benefits of achieving LEED™ certification include significant gains in worker health, improved satisfaction which leads to increase productivity, higher profits, and decreased employee turnover; which ultimately add value to the building.

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